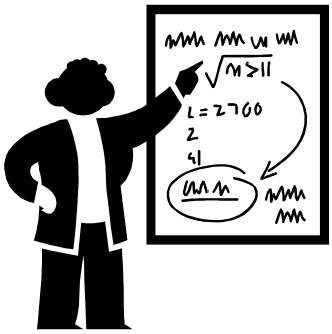
Enhancements to ARC Traffic Model, 2000-2004

2004 TMIP ARC Modeling Peer Review



ARC Travel Demand Modeling Team

Guy Rousseau, Program Manager
- Modeling Applications & Models Development

Claudette Dillard, Principal Planner
- Highway Network Coding, Surveys & Studies

Curt Davis, Principal Planner
- Highway Network Coding, Database Implementation

Laura Chen, Senior Planner
- Highway Network Coding, GIS-T & Census / SE Data

Kandace Lewis, Senior Planner
- Highway Network Coding, Performance Measures

Jean Hee Park, Senior Planner
- Transit Network Coding, Development of Regional Impact (DRI)

Surveys and Studies

•2000-1 Household Travel Survey (SMARTRAQ):
2-day survey, 8000 households surveyed, or about 1/200 household

•2001 Transit On-Board Survey

•1999 Establishment Survey

•2000 Hartsfield Jackson International Airport Survey

•2000-2001 Speed Studies & Travel Time Studies

Traffic Modeling Platform/Environment

•Converted Model Stream from TRANPLAN to TP+

Socio-Economic (SE) Data

•Updated Using Census 2000 Datasets (CTPP)

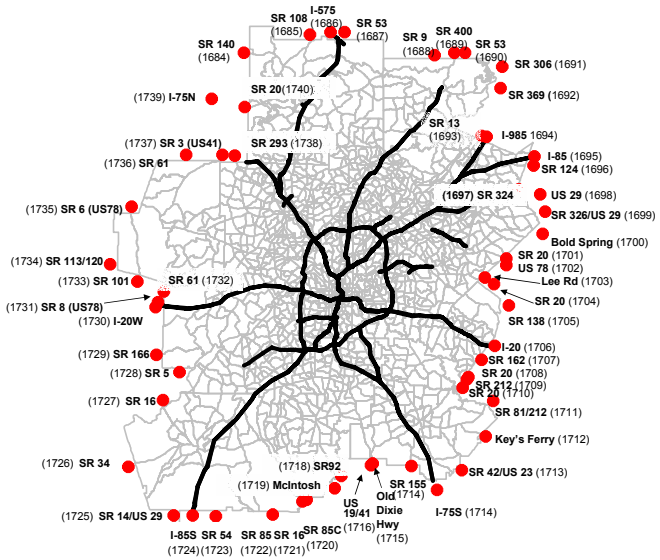
•Updated Base Year 2000 Colleges & Universities Enrollment

•589 Census Tracts (from DRAM/EMPAL) SE Data
disaggregated into 1683 internal TAZ

ARC Highway Networks & Related TAZ structure

- Expanded Zonal Structure from 948 internal TAZ to 1683, maintained External Stations to 57 zones, for a grand total of 1740 TAZ, compared to 1005 previously
- QA/QC 2000 Base Year Highway Network using GIS-T techniques and Aerial Photography
- Revisited Centroid Connectors to accommodate new internal TAZ geometric reconfiguration
- Expanded facility type definitions
- Refined Facility Types Definitions using ARC CMS Strategic Arterial System Definitions
- Updated Free-Flow Speeds and Capacities Look-Up Tables, based upon 2000-2001 travel times and speed studies

ARC 57 External Stations

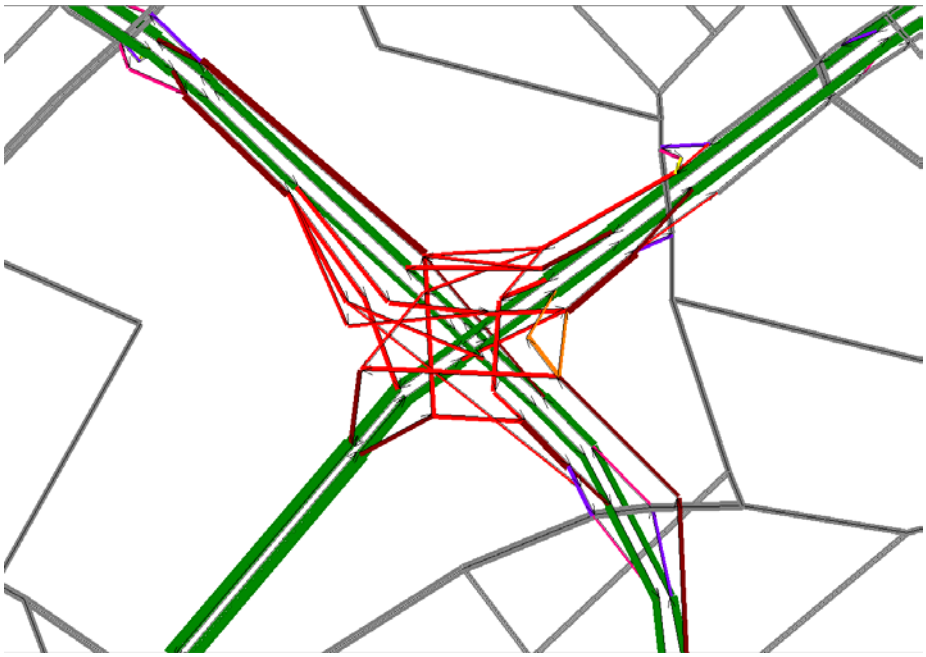


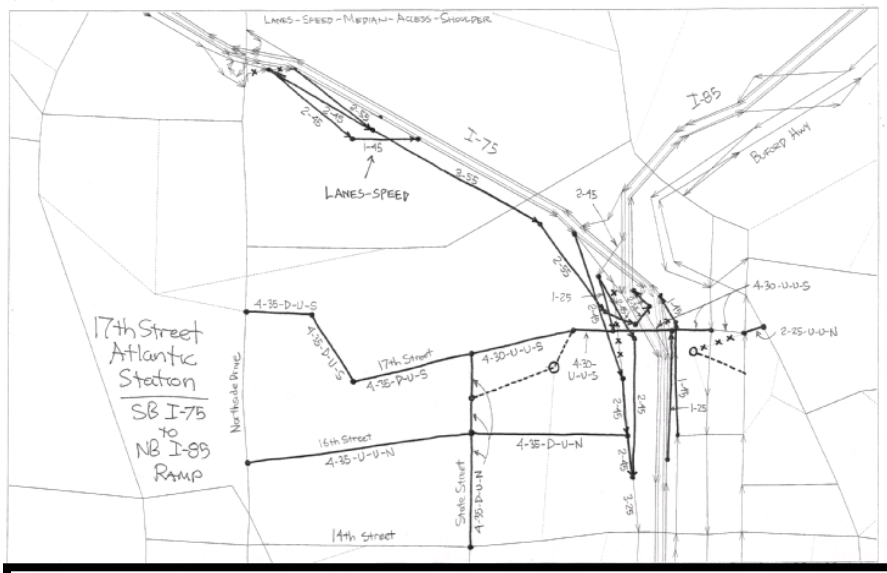
ARC Facility Types

0	Centroid Connectors
1	Interstate / Freeway
2	Parkway
3	HOV Buffer Separated
4	HOV Barrier Separated
5	High Speed Ramp / CD Road
6	Medium Speed Ramp
7	Low Speed Ramp
8	Loop Ramp
9	Off Ramp w/ Intersection
10	On Ramp w/ Intersection
11	Expressway
12	Principal Arterial - Class I
13	Principal Arterial - Class II
14	Minor Arterial - Class I
15	Minor Arterial - Class II
16	HOV - Arterial (all classes)
17	Major Collector
18	Minor Collector / Other Local
19	Planned Ramps w/ Intersections
20	Planned Directional Ramps
50	Transit Only Link: Neighborhood Local
51	Transit Only Link: Local Roads and Collectors
52	Transit Only Link: Park-n-ride lot connector
53	Transit Only Link: Transfer links between rail and bus
54	Associated with BRT Routes (Future year coding)

“Spaghetti Junction” (I-85 @ I-285)

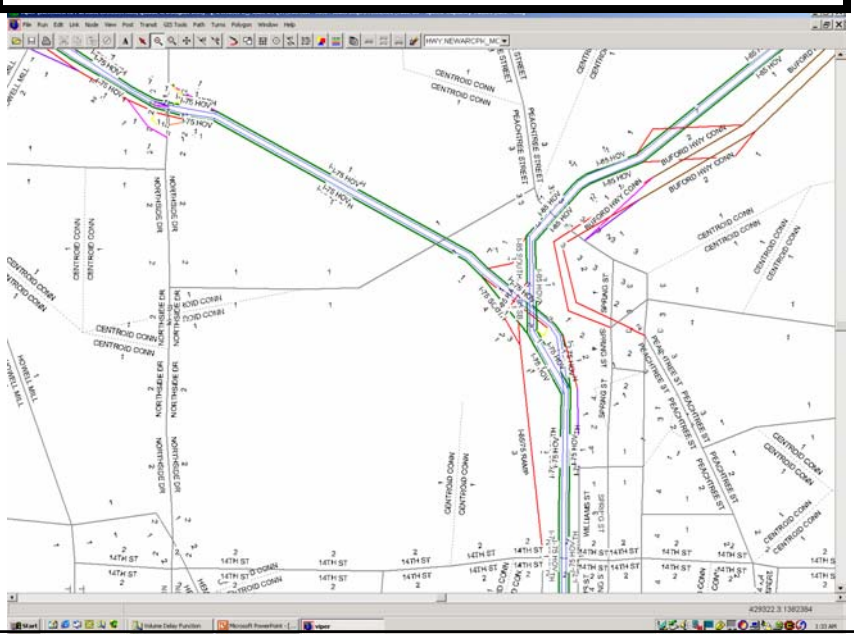
“Spaghetti Junction” (I-85 @ I-285)

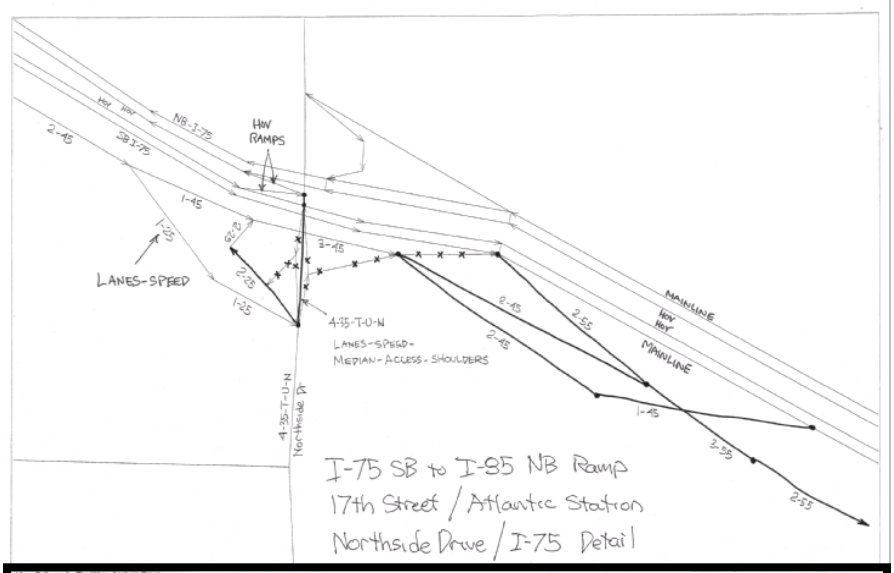




Atlantic Steel Site Development

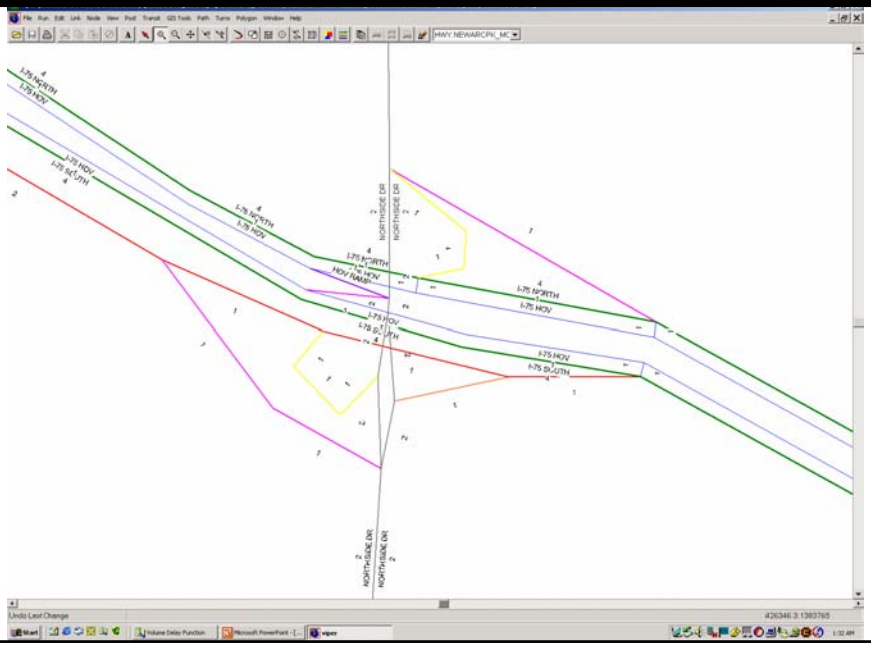
Atlantic Steel Site

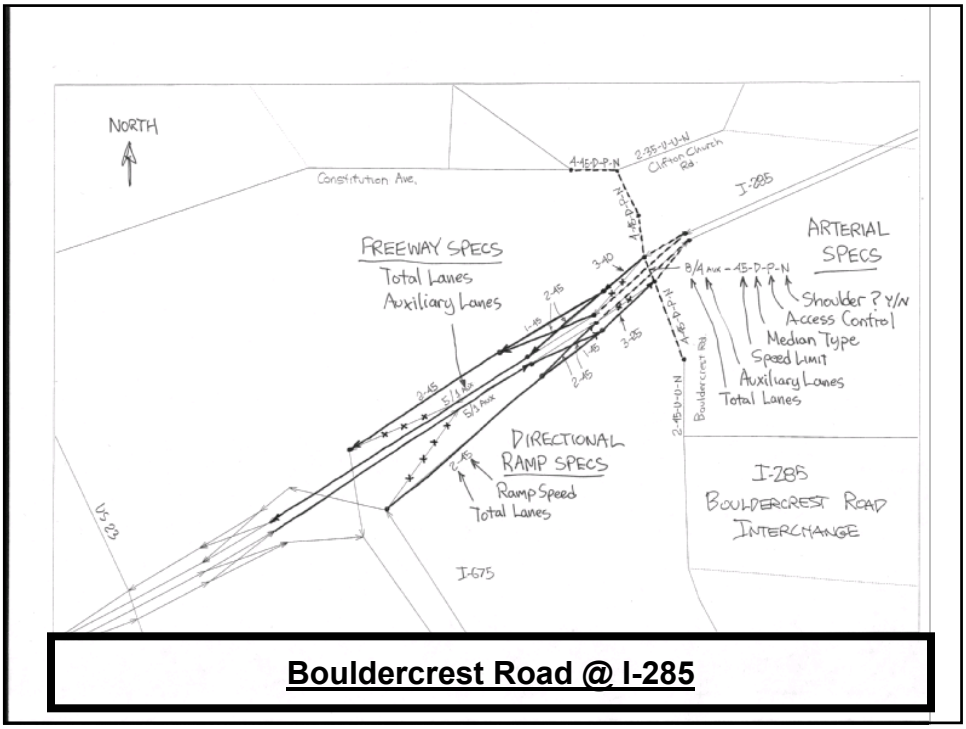




Northside Drive @ I-75

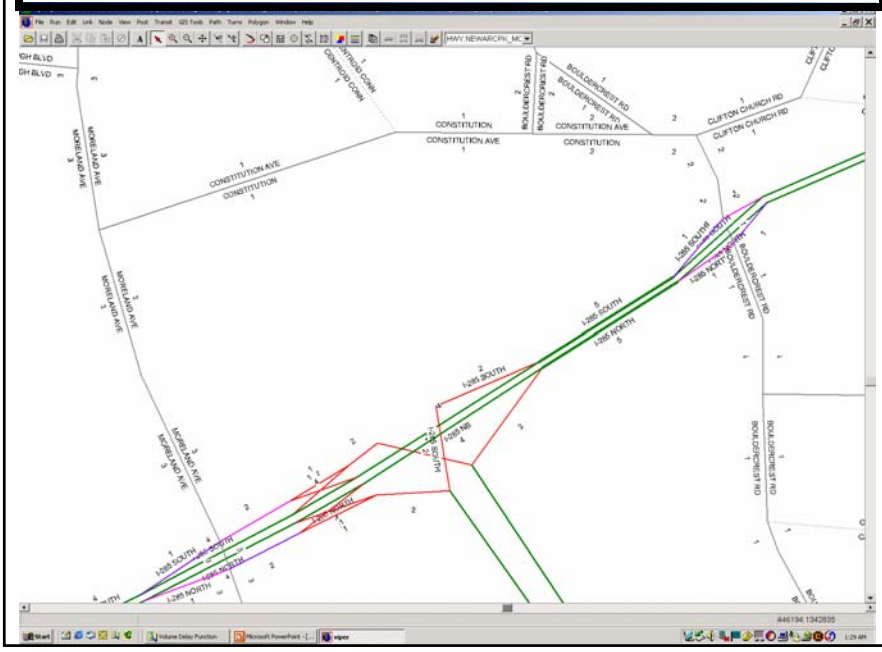
Northside Drive @ I-75



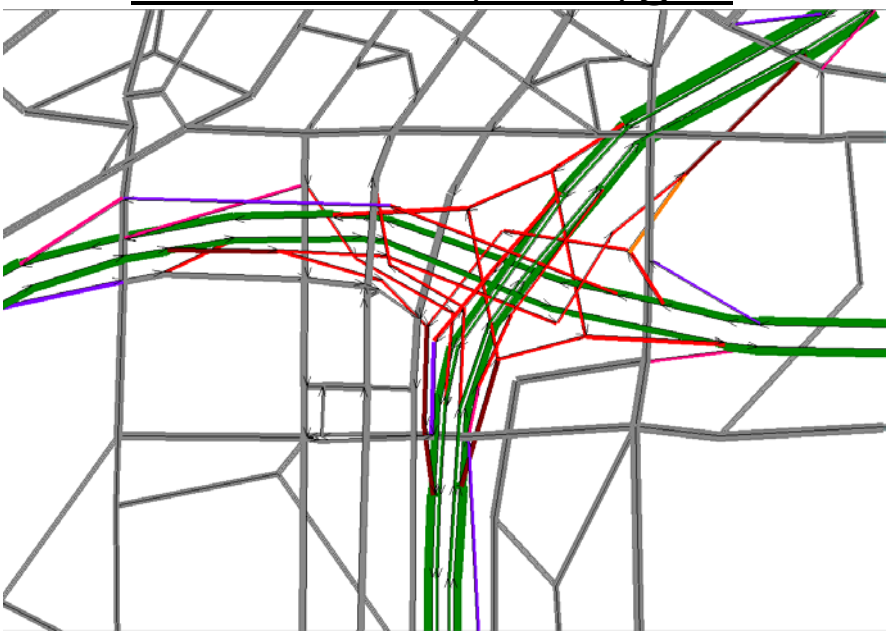


Bouldercrest Road @ I-285

Bouldercrest Road @ I-285



Downtown Connector (I-75 / I-85) @ I-20



ARC-Coded ITS Strategies for Future Network Years (2030)

- Advanced Traffic Signal Coordination and Control
- Fiber-optic Communications
- Video Surveillance and Data Collection on Entire Corridors
- Activity Center Surveillance at Interstate Highway Crossings, Industrial Yards, Shopping Malls, Cross Regional Corridors
- Facilities Parallel to Interstate Highways
- Variable Message Signs (VMS) at Major Decision Points on Freeways
- Transit Vehicle Signal Priority
- Automated Vehicle Location (AVL) for Transit
- Electronic Fare Payment for Transit Service
- Queue Jumper Lanes for Transit
- Ramp Metering on Freeways

ITS benefits expressed in terms of:

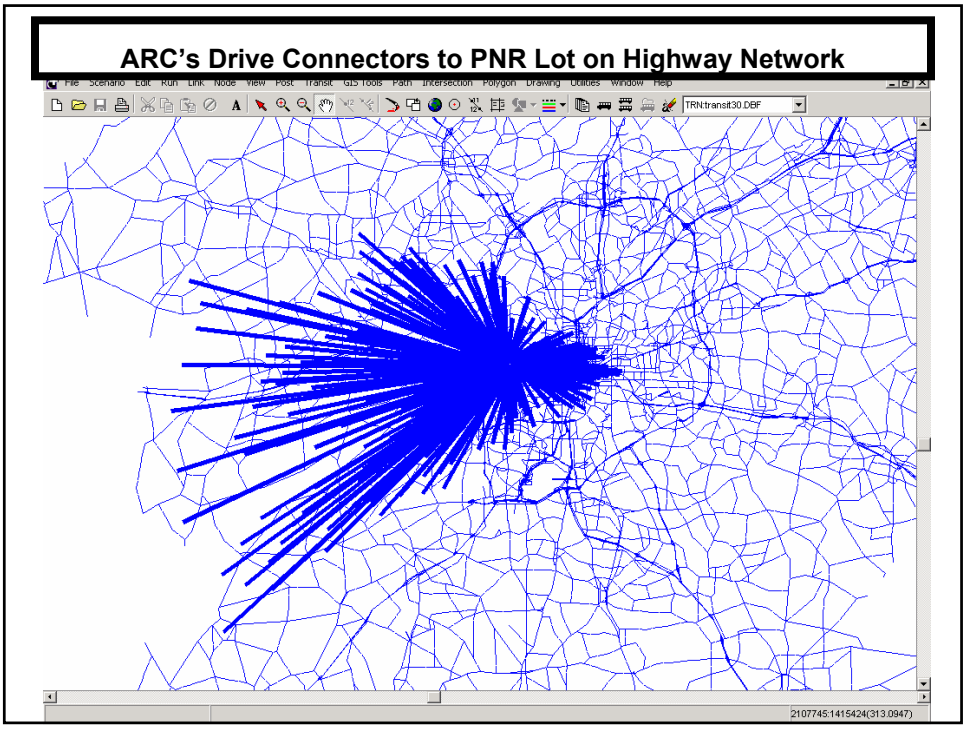
- travel time savings
- delay reductions
- free-flow speeds increases
- localized transit mode share increases

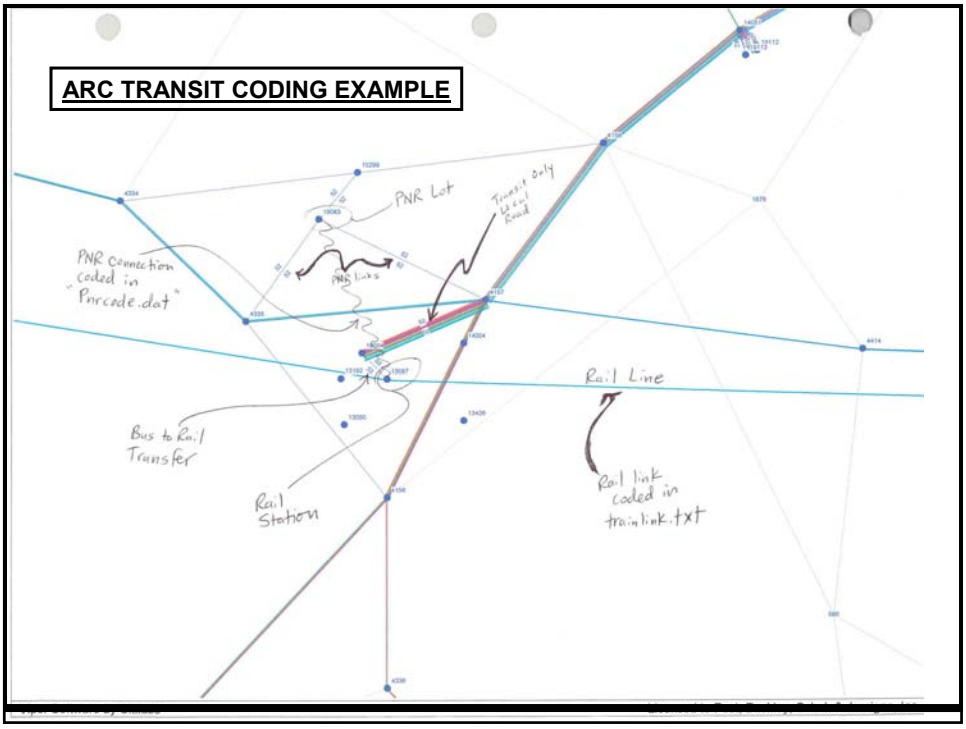
ARC's Transit Networks

- Developed a Bus Speed Model
  - Empirical model to hook bus speeds with congested highway travel times, reflecting mixed flow of traffic operating conditions
  - Stratified by area types and facility types
- Defined 3 types of transit service access
  - Walk to local bus service
  - Walk to premium (with local bus & rail)
  - Drive to transit
- Separated walk to local from walk to premium
- Automated procedures for walk-to-transit links, with maximum length based on area of zone
- Separated Park-And-Ride (PNR) lots by types, local VS premium
  - Local, max access time = 15 minutes
  - Premium, max access time = 60 minutes
- Created procedures to build drive to premium PNR lots to focus on appropriate market, minimizing illogical paths. Max access time increases as market direction is approached
- Refined mode-to-mode transfer prohibitions, improving transit paths
- Improved Bus Rapid Transit (BRT) coding methods

Operator	Mode	Mode #
MARTA		
	Local Bus/BRT	14
	Heavy Rail/High Speed BRT	15
	Express Bus/BRT	16
	Light Rail	18
CCT		
	Local Bus/BRT	24
	Express Bus/BRT	26
Clayton County		
	Local Bus/BRT	34
	Express Bus/BRT	36
Gwinnett County		
	Local Bus/BRT	44
	Express Bus/BRT	46
State Owned		
	Local Bus/BRT	54
	Express Bus/BRT	56
	Commuter Rail	57
	Light Rail	58
Greyhound	Express Bus	66

ARC's Drive Connectors to PNR Lot on Highway Network





ARC's Trip Generation

- Production Model: Set of Logit Models stratified by trip purposes and person types
  - 6 Trip Purposes
    - HBW Home-Based Work
    - HBShop Home-Based Shop
    - HBO Home-Based Other
    - HBU Home-Based University (age of traveler: 19+)
    - HBSchool Home-Based Grade School (age of traveler: under 19)
    - NHB Non-Home Based
  - 3 Person Types
    - Adult worker (age 16+ with full or part time job)
    - Non-Working Adult
    - Child (age 15 or younger)
  - 5 Socio-Economic Independent Variables, by household
    - Household size (1,2,3,4+)
    - Household income ($0-$20K, 20-50, 50-100, $100K+)
    - Workers per Household (0,1,2,3+)
    - Children per Household (0,1,2,3+)
    - Autos per Household (0,1,2,3+)

ARC's Trip Generation – Production Model

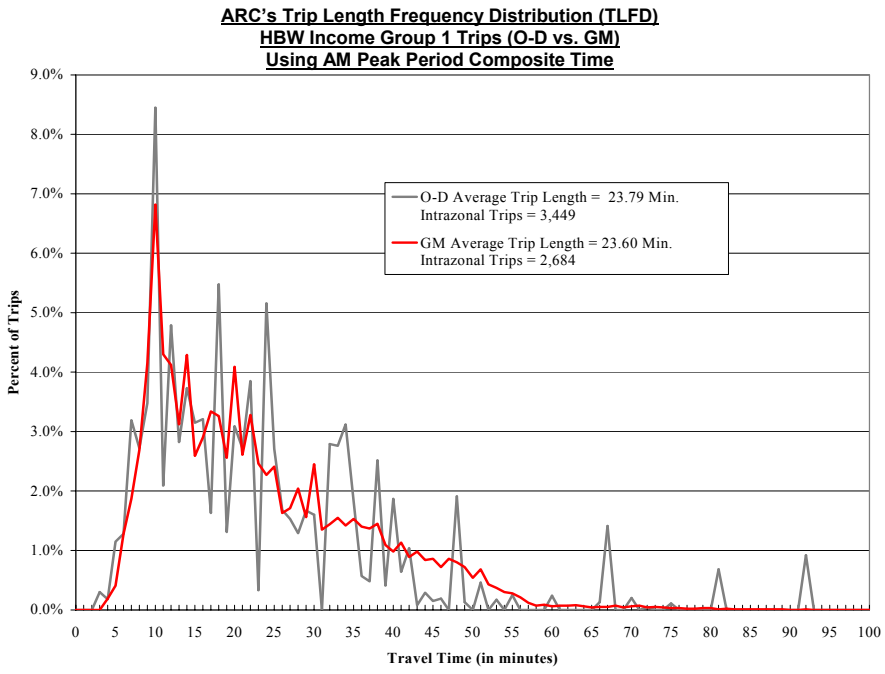
- Estimates probabilities of a person making:
  - 0 trip, I trip, 2 trips, 3 trips, 4+ trips
- Converts to trip rates/person by person type
- Estimates non-motorized trips, including consideration of household access by income for transit and highway time
- Based on 2000-2001 household travel survey

ARC's Trip Generation – Attraction Model

- Cross classification for HBW, HBShop, HBO, NHB
  Regression for HBSchool, HBU
- Stratified by 4 trip purposes, all 4 are a 2-way cross-class matrix of trip rates per employee, or person, or household.
- Trip rates for each of the 4 purposes, one for each type of demographic data: types of households, persons and employment (8 types, construction, manufacturing, retail, TCU, wholesale, FIRE, service, government), and one for each of the 7 area types (based on density, CBD, Urb Com, Urb Res, Suburb Com, Suburb Res, Exurb, Rural)
- Based on 1999 Establishment Survey

ARC's Trip Distribution

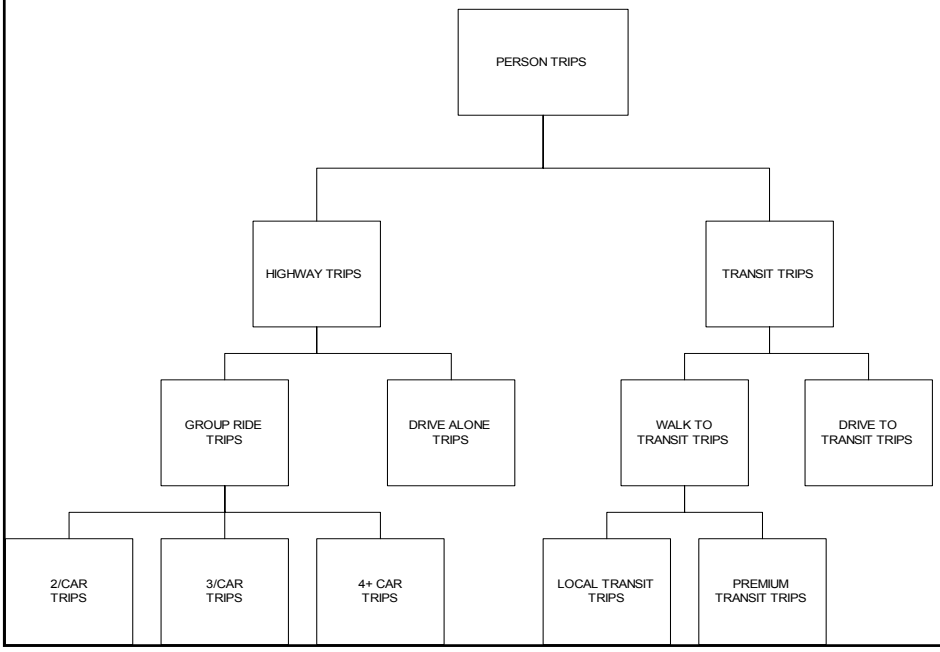
- Use separate gravity model for each of the 6 trip purposes
- Separate friction factors for each of the 6 trip purposes by the 4 income groups
- Composite time (highway and transit time) used as impedance variable
- HBW uses AM peak period skims
- All other trip purposes use free-flow skims with separate topographic penalties added, those are area biases, such as the Chattahoochee River



ARC's Mode Split

- Fully Nested Logit for HBW, HBO (or HBNW, Non-Work), NHB
- HBW uses AM peak period skims
- HBO & NHB use mid-day skims
- Use TP+ procedures for % walk to transit by taz, via a grid with results similar to GIS TIGER path
- Added bus miles, local only transit service and suburban drive variables
- Automated bus miles calculations
- Calibration targets from MARTA/CCT boarding and local surveys, using ALOGIT software
- Works with FTA's New Starts 'Summit' Program

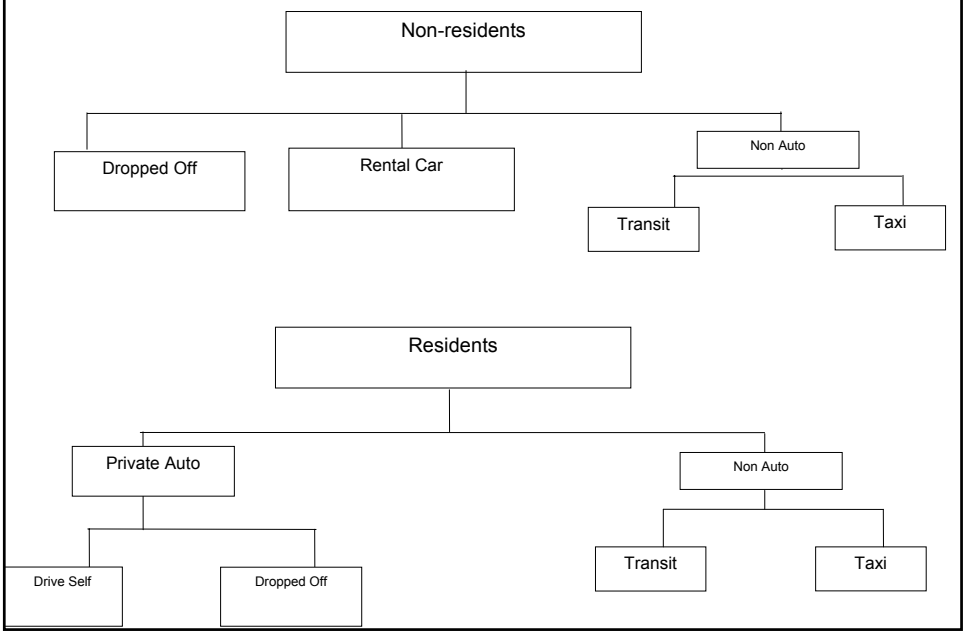
ARC Mode Choice Nesting Structure



ARC Special Generator: Airport Passenger Model

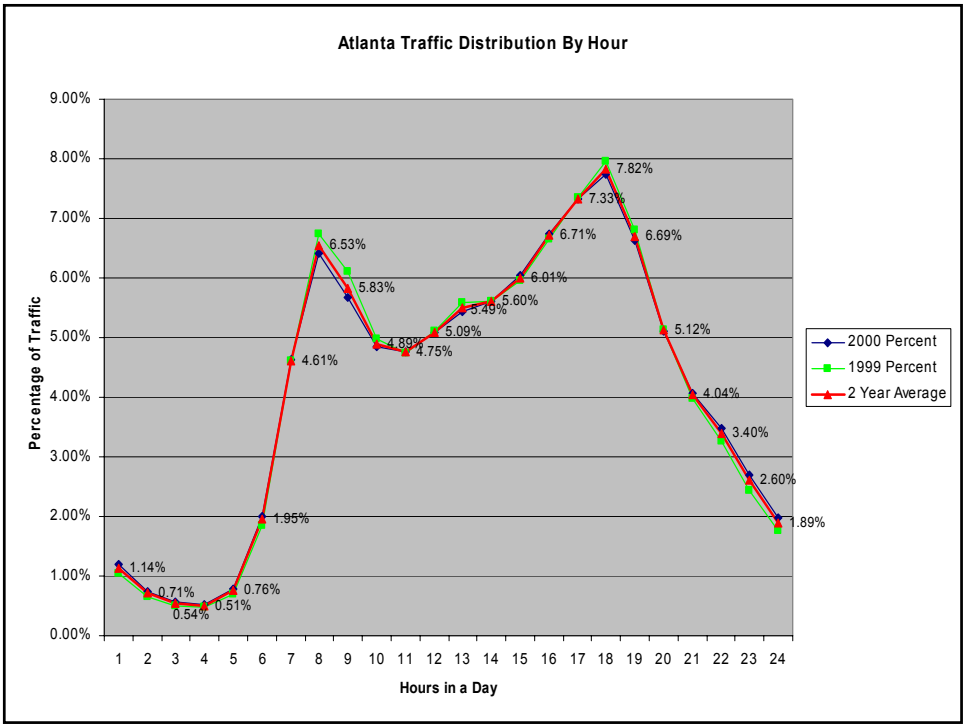
- Estimates average daily air passengers to and from the airport by:
  - Purpose (business VS leisure)
  - Residence Type (resident VS non-resident)
- Total air passengers are allocated to ground site locations based on:
  - Households by income level
  - Total employment
- Features a nested logit model with different structures and modal options for residents and non-residents
- Based on 2000 Hartsfield Air Passenger Survey

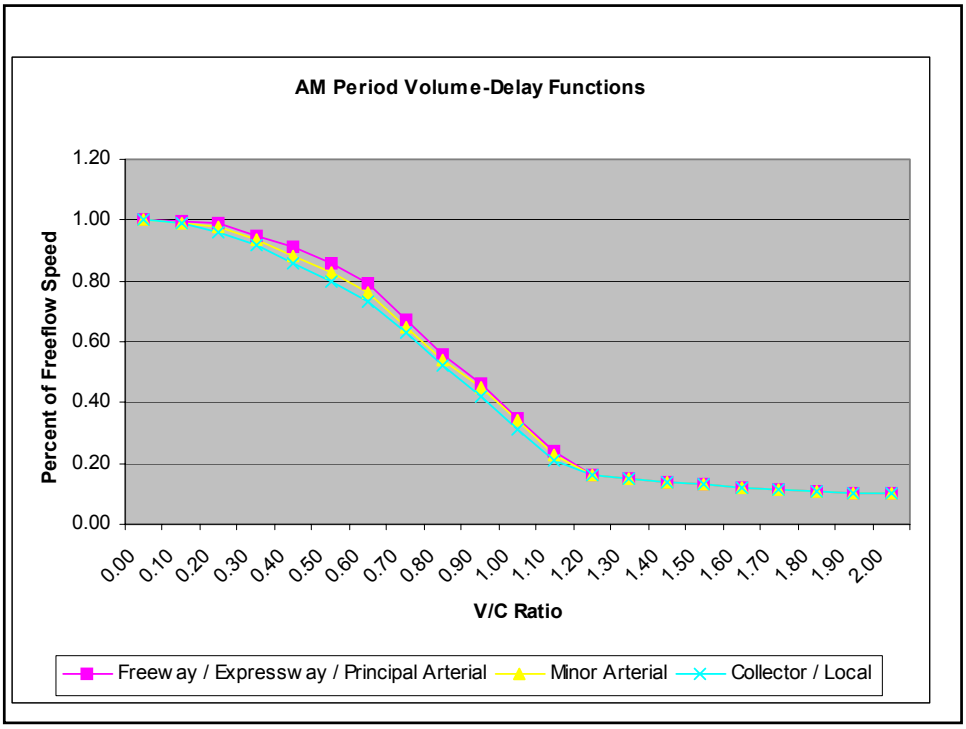
ARC Air Passenger Mode Choice Structure

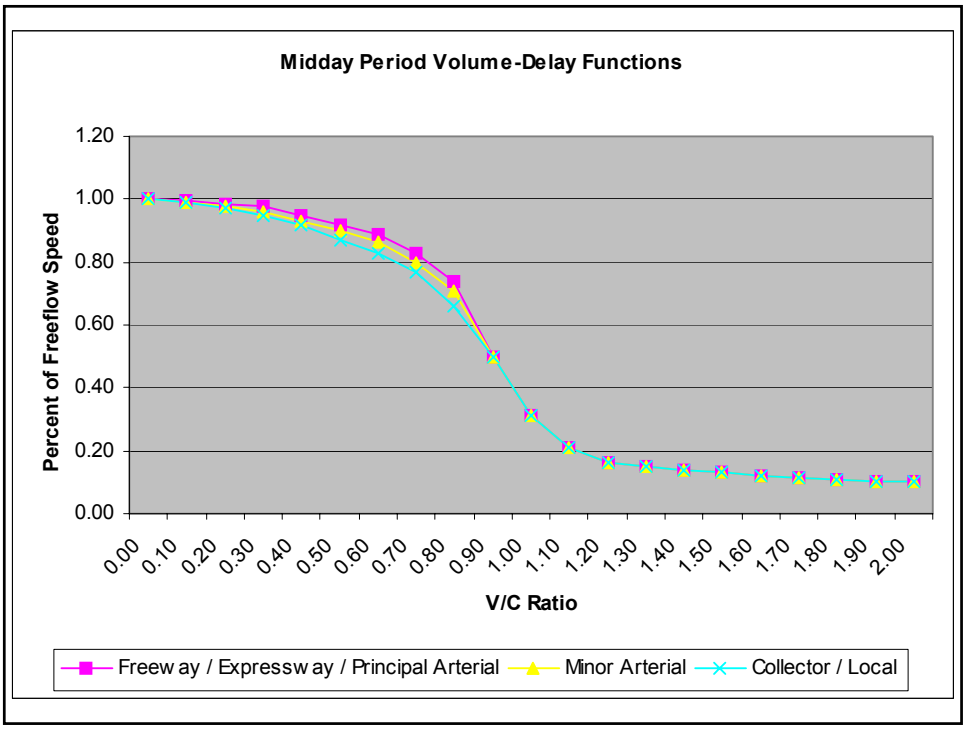


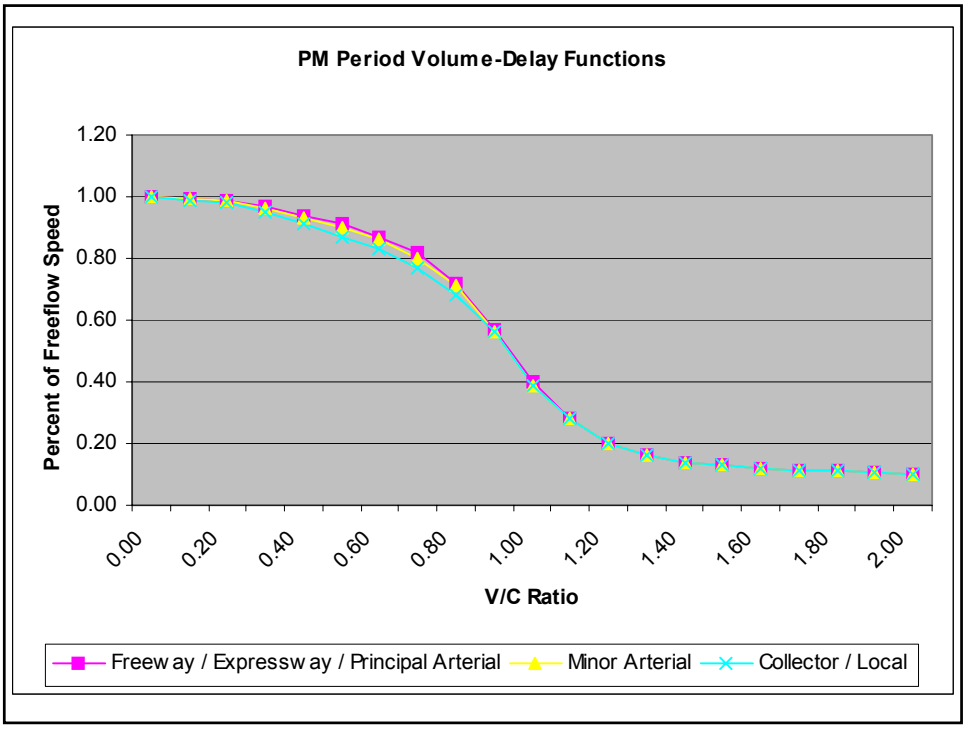
ARC's Highway Assignment

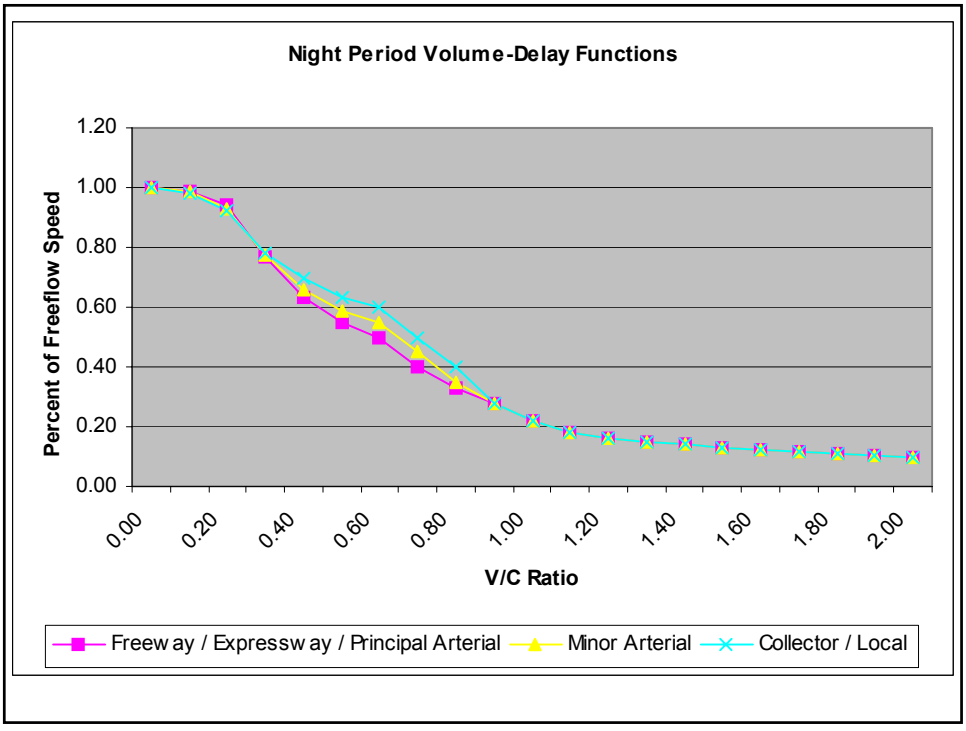
- Created 4 time of day (TOD) assignments:
  - AM peak (6am-10am)
  - Mid-day (10am-3 pm)
  - PM peak (3pm-7pm)
  - Evening/Night (7pm-6am)
- VDF curves grouped by facility types and TOD
- Revised toll diversion model, where time penalty use value-of-time conversion (fixed toll on GA-400)
- Managed lanes (HOT lanes): toll for SOV and trucks based on previous assignment iteration's link v/c ratio, where the toll is distance-based (toll on a per mile basis)
- Feedback loop extends from trip generation to highway assignment (5 feedback loops, 25 equilibrium iterations)
- Tested Induced Demand / Induced Travel effects caused by highway improvements. ARC model includes induced trip effects, both in route diversion and total trip changes. The model shows induced effects, in route diversion, similar to the elasticity produced by research and observed traffic changes.

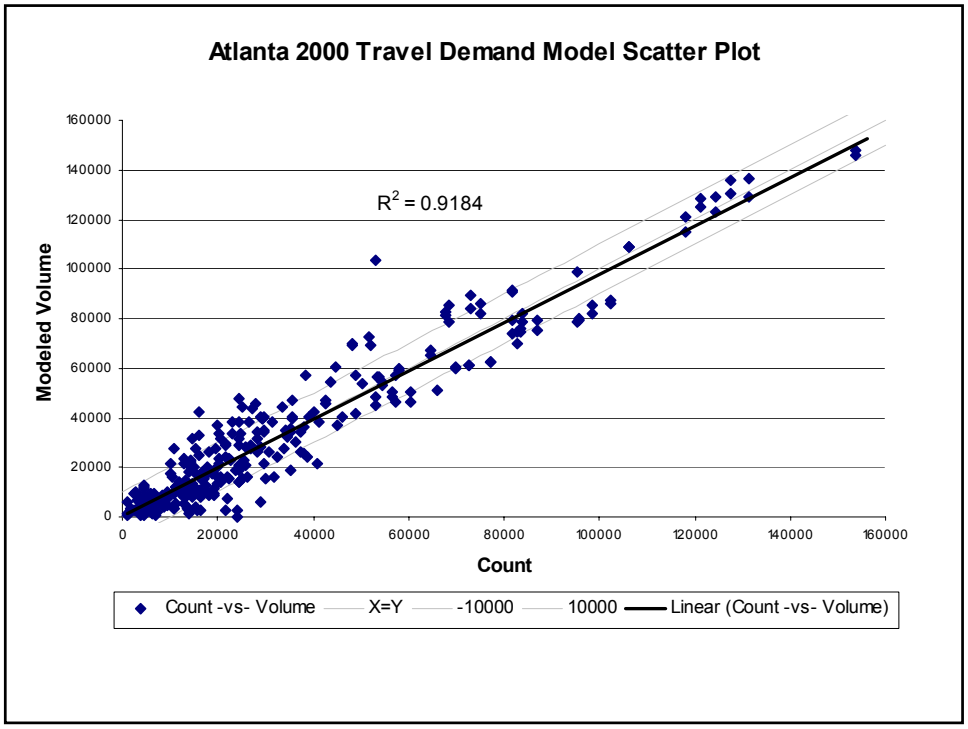


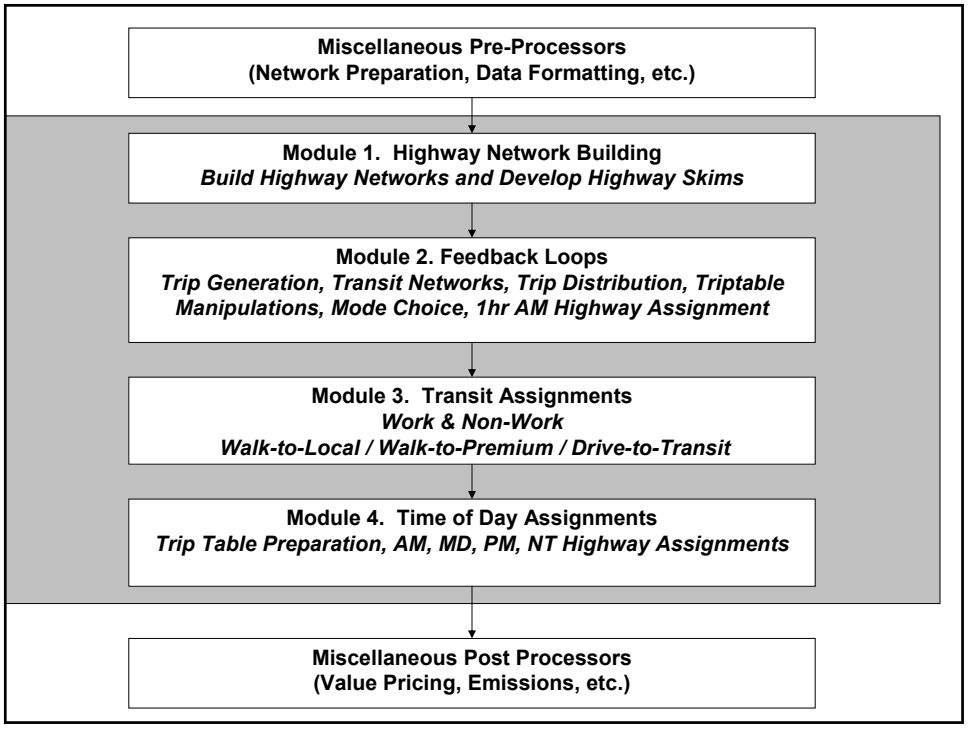

AM Period Volume-Delay Functions
Percent of Freeflow Speed
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00
V/C Ratio
Freeway / Expressway / Principal Arterial
Minor Arterial
Collector / Local


Midday Period Volume-Delay Functions
Percent of Freeflow Speed
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00
V/C Ratio
Freeway / Expressway / Principal Arterial
Minor Arterial
Collector / Local

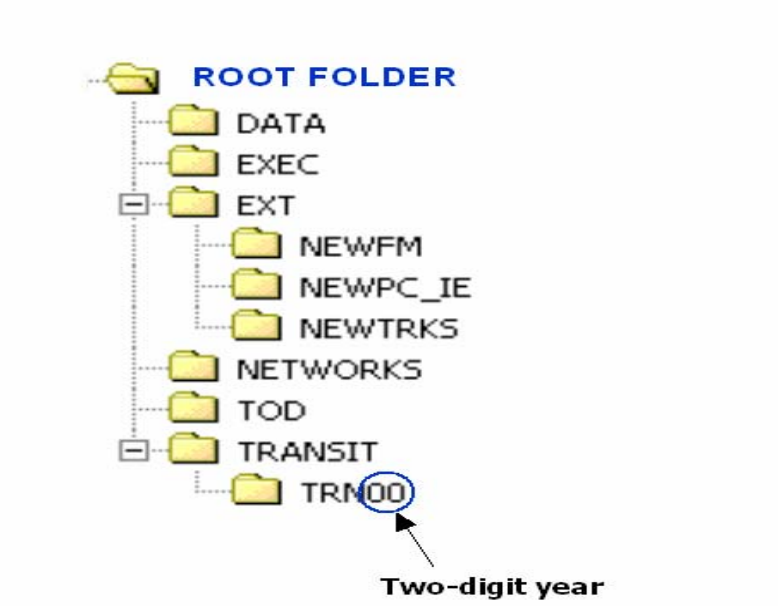

PM Period Volume-Delay Functions
Percent of Freeflow Speed
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
V/C Ratio
Freeway / Expressway / Principal Arterial
Minor Arterial
Collector / Local

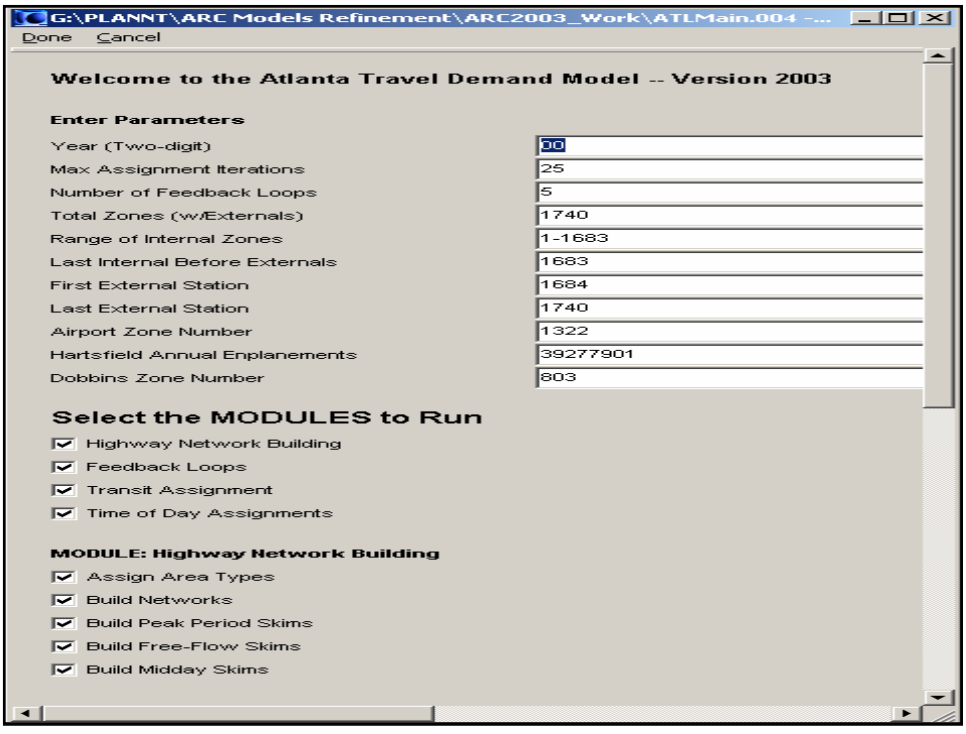

Night Period Volume-Delay Functions
Percent of Freeflow Speed
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
V/C Ratio
Freeway / Expressway / Principal Arterial
Minor Arterial
Collector / Local

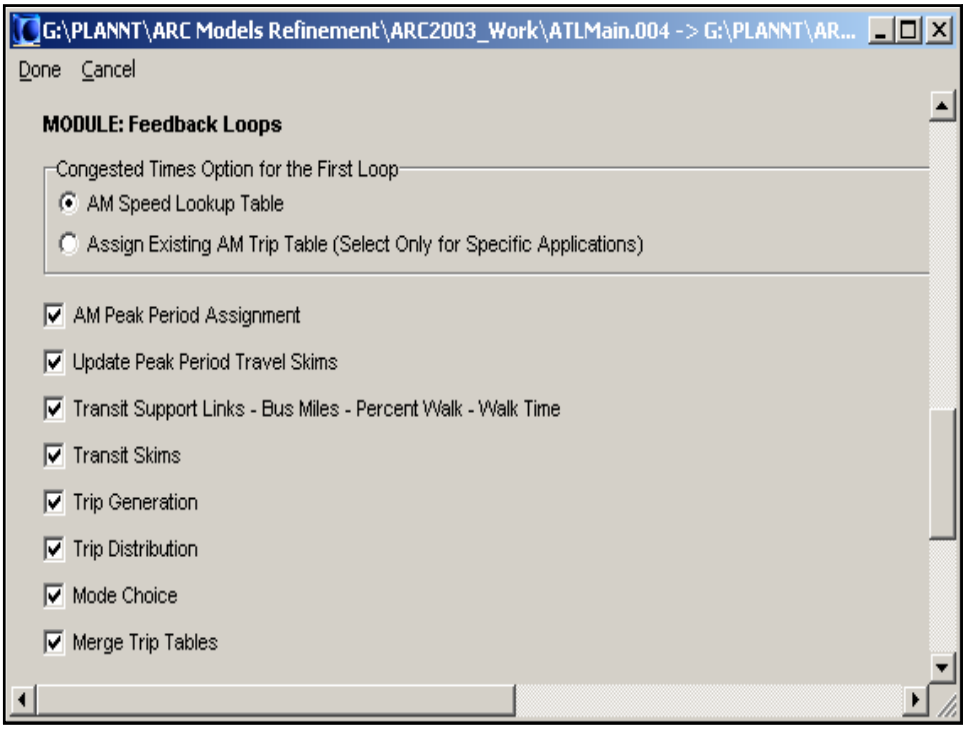

Atlanta 2000 Travel Demand Model Scatter Plot
Modeled Volume
Count
R^2 = 0.9184
0
20000
40000
60000
80000
100000
120000
140000
160000
Count -vs- Volume
X=Y
-10000
10000
Linear (Count -vs- Volume)

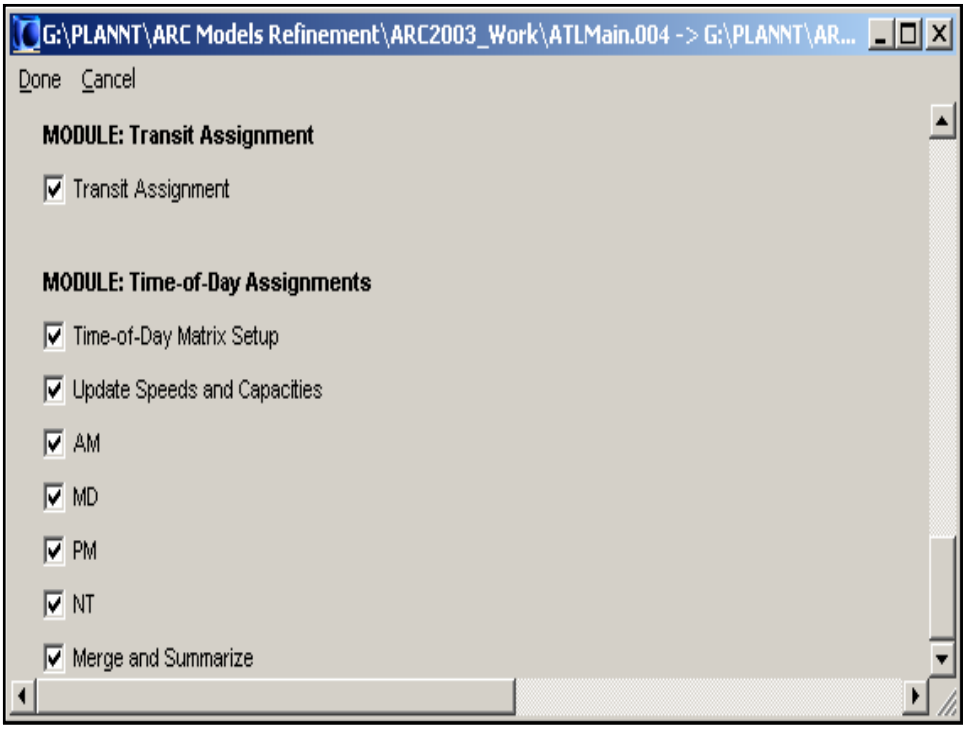

Miscellaneous Pre-Processors
(Network Preparation, Data Formatting, etc.)
Module 1. Highway Network Building
Build Highway Networks and Develop Highway Skims
Module 2. Feedback Loops
Trip Generation, Transit Networks, Trip Distribution, Triptable Manipulations, Mode Choice, 1hr AM Highway Assignment
Module 3. Transit Assignments
Work & Non-Work
Walk-to-Local / Walk-to-Premium / Drive-to-Transit
Module 4. Time of Day Assignments
Trip Table Preparation, AM, MD, PM, NT Highway Assignments
Miscellaneous Post Processors
(Value Pricing, Emissions, etc.)

ARC Modeling Directory Structure






G:\PLANNT\ARC Models Refinement\ARC2003_Work\ATLMain.004 -> G:\PLANNT\AR...
Done
Cancel
MODULE: Feedback Loops
Congested Times Option for the First Loop
AM Speed Lookup Table
Assign Existing AM Trip Table (Select Only for Specific Applications)
AM Peak Period Assignment
Update Peak Period Travel Skims
Transit Support Links - Bus Miles - Percent Walk - Walk Time
Transit Skims
Trip Generation
Trip Distribution
Mode Choice
Merge Trip Tables


G:\PLANNT\ARC Models Refinement\ARC2003_Work\ATLMain.004 -> G:\PLANNT\AR...
Done
Cancel
MODULE: Transit Assignment
Transit Assignment
MODULE: Time-of-Day Assignments
Time-of-Day Matrix Setup
Update Speeds and Capacities
AM
MD
PM
NT
Merge and Summarize

ARC 2000 Base Year & 2030 Model Results

POPULATION	3,630,560	5,869,086
HOUSEHOLDS	1,356,058	2.323.443
EMPLOYMENT	2,067,000	3,310,428
HOME-BASED WORK		
Walk to Local Transit Trips	41,727	81,018
Walk to Premium Transit Trips	88,009	156,553
Drive to Transit Trips	33,039	58,105
Low Occupancy (SOV) Vehicle Trips	2,101,702	3,326,176
Low Occupancy (SOV) Person Trips	2,101,702	3,326,176
High Occupancy (HOV) Vehicle Trips	100,773	161,864
High Occupancy (HOV) Person Trips	265,608	425,497
Total HBW Transit	162,775	295,676
Total HBW Vehicles	2,202,475	3,488,040
Total HBW Persons	2,530,085	4,047,349
Percent HBW Mode Split	6.4%	7.3%

MODE CHOICE SUMMARY AFTER APPLICATION OF AIR PASSENGER

TOTAL TRANSIT TRIPS	300,394	536,311
Total Walk to Local Transit	67,607	127,385
Total Walk to Premium Transit	174,396	305,416
Total Drive to Transit	58,391	103,510
TOTAL VEHICLE TRIPS	8,704,643	13,913,716
Total SOV Vehicle Trips	7,086,937	11,418,287
Total HOV Vehicle Trips	1,617,706	2,495,429
TOTAL PERSON TRIPS	11,919,551	18,939,249
Total SOV Person Trips	7,086,937	11,418,287
Total HOV Person Trips	4,532,220	6,984,651
Total Transit Trips	300,394	536,311
TOTAL MODE SPLIT (Percent)	2.5%	2.8%

EXTERNAL-EXTERNAL VEHICLE TRIPS

Passenger Cars	46,347	82,116
Trucks	15,482	25,538
TOTAL E-E TRIPS	61,829	107,654

PERSON TRIP TABLE BY PURPOSE

Home-Based Work	2,530,080	4,047,349
Home-Based Other	5,597,463	8,701,930
Non Home-Based	3,689,765	5,960,941
TOTAL PERSON TRIPS	11,817,308	18,710,220

INTERNAL-EXTERNAL TRIPS

WORK TRIPS

I-E Work - Interstate	136,630	258,988
I-E Work - Non-Interstate	153,887	310,221
Total I-E Work Trips	290,517	569,209

NON-WORK TRIPS

I-E Non-Work - Interstate	172,343	324,150
I-E Non-Work - Non-Interstate	194,604	392,302
Total I-E Non-Work Trips	366,947	716,452
TOTAL I-E TRIPS	657,464	1,285,661

TRUCK TRIPS

I-I Light Duty Trucks	1,002,446	1,601,795
I-I Heavy Duty Trucks	325,539	526,210
I-E Light Duty Trucks	67,423	121,047
I-E Heavy Duty Trucks	41,308	73,564
TOTAL TRUCK TRIPS	1,436,716	2,322,616

TOTAL DAILY VEHICLE TRIP TABLE

Truck Vehicle Trips	1,452,644	2,348,623
SOV Vehicle Trips	7,791,171	12,786,515
HOV Vehicle Trips	1,618,118	2,495,860
TOTAL DAILY VEHICLE TRIPS	10,861,933	17,630,998

TIME OF DAY VEHICLE TRIP TABLES

AM		
Truck Vehicle Trips	441,335	713,524
SOV Vehicle Trips	1,666,374	2,725,832
HOV Vehicle Trips	242,891	374,991
TOTAL AM VEHICLE TRIPS	2,350,600	3,814,347
MD		
Truck Vehicle Trips	673,011	1,088,369
SOV Vehicle Trips	2,237,793	3,673,823
HOV Vehicle Trips	541,564	842,693
TOTAL MD VEHICLE TRIPS	3,452,368	5,604,885
PM		
Truck Vehicle Trips	249,231	402,959
SOV Vehicle Trips	3,002,758	4,915,170
HOV Vehicle Trips	666,732	1,020,788
TOTAL PM VEHICLE TRIPS	3,918,721	6,338,917
NT		
Truck Vehicle Trips	88,584	143,245
SOV Vehicle Trips	879,626	1,464,552
HOV Vehicle Trips	165,961	256,106
TOTAL NT VEHICLE TRIPS	1,134,171	1,863,903

VEHICLE MILES TRAVELED

AM VMT	29,231,507	46,269,810
MD VMT	34,755,605	56,293,733
PM VMT	40,286,588	64,089,408
NT VMT	13,398,933	21,578,644
TOTAL DAILY VMT	117,672,632	188,231,596

44% of VMT on freeway
39% of VMT on arterial
17% of VMT on local/collector

While freeways have more VMT than arterials in 2000,
they have only 60% of the hourly capacity of the arterials.
However per-lane freeway capacity is 4 to 5 times as great as arterials.

VEHICLE HOURS TRAVELED

AM VHT	834,692	1,360,637
MD VHT	1,011,084	1,682,856
PM VHT	1,196,474	1,964,960
NT VHT	375,714	599,284
TOTAL DAILY VHT	3,417,963	5,607,736

CONGESTED VEHICLE HOURS TRAVELED

AM CONGESTED VHT	985,136	1,801,623
MD CONGESTED VHT	1,202,100	2,242,139
PM CONGESTED VHT	1,397,435	2,557,559
NT CONGESTED VHT	449,635	823,561
TOTAL DAILY CONGESTED VHT	4,034,306	7,424,882

AVERAGE HIGHWAY SPEEDS

Daily Free-Flow Average Speed	34.4	33.6
Daily Congested Average Speed	29.2	25.4

VEHICLE MILES TRAVELED SUMMARY

VMT per Capita	32.4	32.1
VMT per Household	86.8	81.0
VMT per Job	56.9	56.9

VEHICLE HOURS TRAVELED SUMMARY

VHT per Capita	1.1	1.3
VHT per Household	3.0	3.2
VHT per Job	2.0	2.2

A Few Recommended Performance Measures for 2030 Plan Analysis

Source: Tim Lomax, TTI, Texas A&M University

"It's more than just Volume/Capacity Ratios"

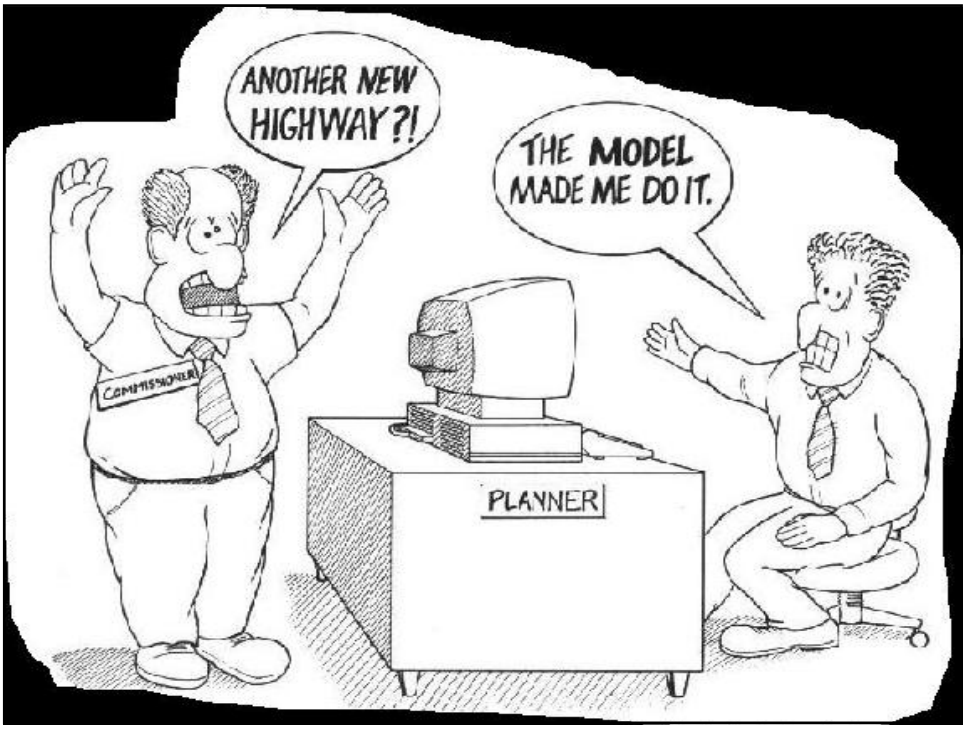
- Individual Delay per Person
- Individual Travel Time per Person ("Planning Time")
- Individual Cost Per Person
- Congestion Index from Texas Transportation Institute
- Total Travel Time
- Total Delay Hours
- Total Cost of Travel & Delay

Next Steps…

- Conversion to Cube's Application Manager, Scenario Manager / Flowchart Approach
- Refine EJ Performance Measures
- Refine Evening / Night TOD Model
- Summarize Model Output by Activity Centers & Town Centers (LCI sites)
- Review the Externals Model

Next Steps (Continued)

- Refine Transit Coding / Modeling & Commuter Rail with "Externals" Input
- Continue Tour-Based & Activity-Based Model Development
- Refine Sketch Modeling Methods
- Perform Commercial Vehicle / Truck Survey and Use Transearch Reebie Data
- Freight Model Development



Guy Rousseau
Modeling Manager

Atlanta Regional Commission
40 Courtland St, NE
Atlanta, GA 30303
404-463-3274
grousseau@atlantaregional.com

www.atlantaregional.com